

**ORDER**

6830.4

**MICROWAVE LANDING SYSTEM (MLS)  
PROJECT IMPLEMENTATION PLAN (PIP)**



September 21, 1992

**U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION**

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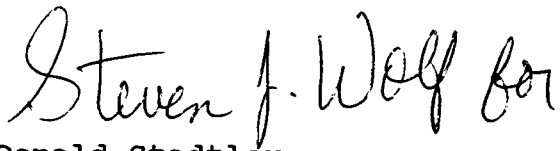
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## FOREWORD

This order transmits the Project Implementation Plan (PIP) which provides direction for the implementation and acceptance of the Microwave Landing System (MLS) Category II/III First Article Test Systems into the National Airspace System (NAS). This order along with the MLS Program Master Plan (PMP) defines major functional responsibility levels, management direction, and overall project guidance to all responsible levels within the Federal Aviation Administration (FAA) for implementation and installation of the MLS first article test systems.



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Program Manager for MLS



## TABLE OF CONTENTS

	<u>Page No.</u>
CHAPTER 1. GENERAL	1
1. Purpose	1
2. Distribution	1
3. Definitions	1
4. Authority to Change This Order	1
5.-19. Reserved	1
CHAPTER 2. PROJECT OVERVIEW	3
20. Synopsis	3
21.-29. Reserved	3
CHAPTER 3. PROJECT DESCRIPTION	5
30. Functional Description	5
Figure 3-1. MLS Block Diagram	6
31.-39. Reserved	5
CHAPTER 4. PROJECT SCHEDULE AND STATUS	7
40. Project Schedules and General Status	7
41. Milestone Schedule Summary	7
42.-49. Reserved	7
CHAPTER 5. PROJECT MANAGEMENT	9
50. Project Management, General	9
51.-59. Reserved	9
CHAPTER 6. PROJECT FUNDING	11
60. Project Funding Status, General	11
61.-69. Reserved	11
CHAPTER 7. DEPLOYMENT	13
70. General Deployment	13

Page No.

Figure 7-1. Standard MLS Ground System Configuration	14
71. Site Preparation	15
72. Installation Plan	16
73.-79. Reserved	16
 CHAPTER 8. VERIFICATION	 17
80. Factory Verification	17
81. Checkout	17
82. Contractor Integration Testing	17
83. Contractor Acceptance Inspection	17
84. FAA Integration Testing	17
85. Shakedown and Changeover	18
86. Joint Acceptance Inspection	18
87. Preliminary Flight Inspection	18
88. Government Commissioning Flight Inspection	18
89. Reserved	18
 CHAPTER 9. INTEGRATED LOGISTICS SUPPORT	 19
90. Maintenance	19
91. Training	19
92. Support Tools and Test Equipment	19
93. Supply Support	20
94. Vendor Data and Technical Manuals	20
95. Packaging, Handling, Storage, and Transportation	20
96.-99. Reserved	20
 APPENDIX 1. LIST OF ACRONYMS	 1
APPENDIX 2. LIST OF APPLICABLE DOCUMENTS	1

## CHAPTER 1. GENERAL

1. PURPOSE. This order transmits the project implementation plan (PIP) which provides guidance and management direction for implementation of Microwave Landing System (MLS) Category II/III First Article Test Systems. This PIP supplements information contained in the MLS Program Master Plan (PMP) and has been prepared in accordance with FAA-STD-036, Preparation of Project Implementation Plans.

2. DISTRIBUTION. This order is distributed to branch level in the office of the Program Directors for Communications and Aircraft Acquisition, Navigation and Landing, Weather and Flight Service Systems; to division level in the NAS System Engineering, Systems Maintenance, Office of Airport Safety and Standards, Aviation System Standards, Office of Acquisition Support, and Air Traffic Plans and Requirements; to branch level in the regional Airway Facilities, Logistics, Airports, Air Traffic, and Flight Standards divisions; to division level in the Engineering, Test and Evaluation Service at the FAA Technical Center; to branch level in the FAA Logistics Center and FAA Academy at the Mike Monroney Aeronautical Center; limited distribution to the Airway Facilities (AF) General National Airspace System (GNAS) sectors, sector field offices, sector field units, and sector field office units.

3. DEFINITIONS. Refer to Appendix 1, List of Acronyms, for definitions of acronyms.

4. AUTHORITY TO CHANGE THIS ORDER. This order is issued under the authority of the Program Manager for MLS, AND-30. Any changes, revisions, or cancellations of this order must be approved by AND-30.

5.-9. RESERVED.





## CHAPTER 2. PROJECT OVERVIEW

20. SYNOPSIS.

a. Program Origin. The MLS is an all-weather approach and landing guidance system jointly developed by the Department of Transportation (DOT), National Aeronautics and Space Administration (NASA), and the Department of Defense (DOD) as a replacement for the existing Instrument Landing System (ILS). The MLS has been selected by the International Civil Aviation Organization (ICAO) as the international replacement for the ILS. The MLS will be gradually integrated into the NAS with full implementation by the year 2008. Most MLS facilities will be collocated with existing ILS facilities for a substantial period of time until aircraft and airport facilities acquire MLS avionics and equipment.

b. Category (CAT) II/III First Article Test System. This project is for the procurement, installation, and testing of a limited quantity of CAT II/III First Article Test (FAT) systems. Two contracts are to be awarded for independent design, development, and test of first article CAT II systems equipped with CAT III conversion kits (fully redundant electronics to enhance reliability). Each contract will include fabrication, test, and delivery of six pre-production FAT systems with options for additional systems. These systems will be used to complete a full Development Test & Evaluation (DT&E) FAT program, an extensive field reliability demonstration, Operational Test and Evaluation/Shakedown Test and Evaluation (OT&E/ST&E), and NAS Integration Test and Evaluation/System Level Test and Evaluation (NAS IT&E/SLT&E). Each contract will provide for necessary logistics support such as test equipment, training, and depot level repair service, with field level maintenance being performed by FAA personnel. The current schedule calls for contract awards in June 1992, initial delivery in April 1996, and completion of FAA testing in July 1996.

c. Production Systems. Full follow-on production contracts are planned for the two contractors qualified by successful completion of the FAT program. The estimated date for the production contract awards is August 1996 with initial delivery in November 1997. Additional project overview information may be found in Chapter 3, Program Objectives and Requirements, of the MLS PMP.

21.-29. RESERVED.



## CHAPTER 3. PROJECT DESCRIPTION

30. FUNCTIONAL DESCRIPTION. MLS is a precision approach and landing guidance system which provides position information and ground-to-air data. MLS is an "air-derived" system where ground transmitters radiate signals which are then received in the aircraft to derive lateral and vertical guidance and range to the runway. Guidance information can be provided over a wide range of azimuth angles up to  $\pm 60$  degrees from the runway centerline and up to 30 degrees in elevation from the surface. A complete MLS ground system comprises azimuth equipment, elevation equipment and precision distance measuring equipment (DME/P). A typical block diagram is shown in figure 3-1. The MLS angle equipments (azimuth and elevation) operate at C-band in the frequency range 5030-5090 MHz. The DME/P equipment operates at L-band in the frequency range 979-1143 MHz. The angle and data functions operate on a single frequency using Time Division Multiplexing (TDM).

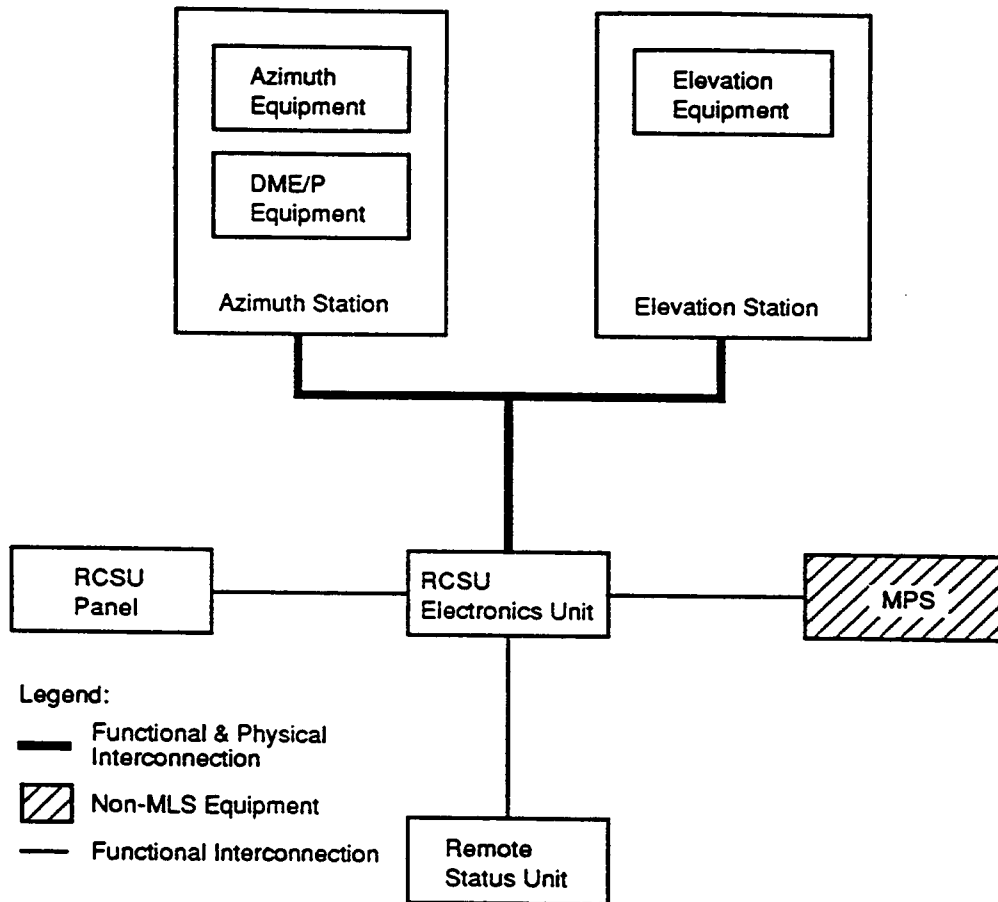
a. The inherent function and accuracy of the MLS is sufficient for both Category II and Category III operation; however, Category III operation requires increased probability that the MLS will continue to radiate guidance signals to support landing operations. This Category III requirement is satisfied through system design for integrity of transmitted signals and by increased reliability in the Category III configuration.

b. Integrity requirements are met via the system executive monitor which utilizes automatic, on-line integrity checks along with off-line end-to-end integrity checks. The executive monitor completely checks all elements of the MLS that would cause erroneous signals to be transmitted, including control circuitry which effects switchover to back-up equipment in the event of an integrity alarm in the primary equipment. Design of the executive monitor is significantly influenced by the extensive Failure Mode, Effects and Criticality Analysis (FMECA) performed by the equipment contractor.

c. Addition of a full set of redundant electronics provides for the required increased reliability of the Category III configuration. This additional back-up electronics, along with a device for switching to back-up equipment in the event of a failure of the primary equipment, is included in the Category III conversion kit. This conversion kit is the only difference between the Category II and Category III configuration.

d. Additional project description information may be found in Chapter 2, Introduction, and Chapter 4, System Description, of the MLS PMP.

31.-39. RESERVED.

FIGURE 3-1. MLS BLOCK DIAGRAM

## CHAPTER 4. PROJECT SCHEDULE AND STATUS

40. PROJECT SCHEDULES AND GENERAL STATUS. Project schedule and status information may be found in Chapter 5, Program Planning, of the MLS PMP.

41. MILESTONE SCHEDULE SUMMARY. A table of project milestones are listed in Table 4-1, MLS CAT II/III Milestones. This table is not an all inclusive list of project milestones necessary for project completion.

TABLE 4-1. MLS CAT II/III MILESTONES

Contract Award	June 1992
Preliminary Design Review	September 1993
Critical Design Review	July 1992
Contractor Preliminary Test	January 1995
In-Plant First Article Test	September 1995
Integration OT&E Testing	March 1996
Field Reliability/Demonstration Tests	September 1996

42.-49. RESERVED.



9/21/92

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## CHAPTER 5. PROJECT MANAGEMENT

50. PROJECT MANAGEMENT, GENERAL. Project management information may be found in Chapter 6, Program Management, of the MLS PMP.

51.-59. RESERVED.





9/21/92

6830.4

## CHAPTER 6. PROJECT FUNDING

60. PROJECT FUNDING STATUS, GENERAL. Project funding information may be found in Chapter 7, Financial, of the MLS PMP.

61.-69. RESERVED.



## CHAPTER 7. DEPLOYMENT

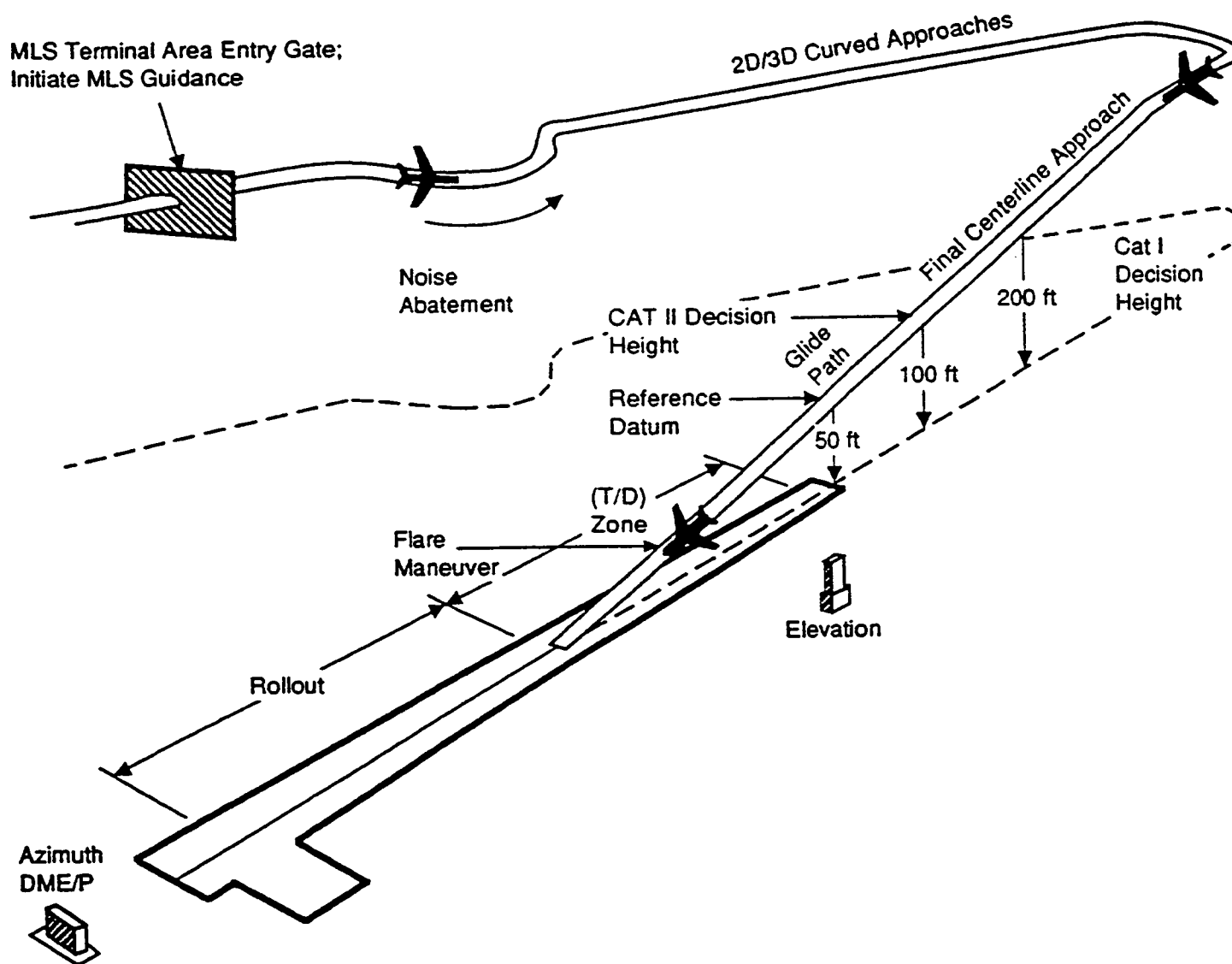
70. GENERAL DEPLOYMENT ASPECTS. Overall deployment will be coordinated by ANN-150 with support from FAA organizations as required. System-level deployment guidelines and requirements will be established by FAA headquarters utilizing inputs from field organizations. Site peculiar deployment aspects will be left to the field organization; however, the overall guidelines established by FAA headquarters must be adhered to. The CAT II/III FAT systems will be installed as a turnkey effort by the developing contractors. A major activity of the Government during the MLS deployment is monitoring and guiding the work of the contractors, providing required procurement inputs such as MLS site locations and frequency assignments, and reviewing contractors' reports and work accomplished. These activities and responsibilities are specified in this order and the MLS PMP. All elements of the deployment will be reviewed during the Deployment Readiness Review (DRR) process.

a. General Siting Considerations. The small size and radiation characteristics of MLS antennas provide flexibility in siting and minimize requirements for site preparations. Narrow beams and controlled antenna patterns reduce radiation outside of the required coverage volume, and the scan coverage limits can be adjusted to further reduce the illumination of troublesome reflecting objects. Also, the provision of out-of-coverage indication signals minimizes undesirable indications to the airborne receiver when multipath signals are received outside the system coverage volume. In most cases, the MLS azimuth and elevation antennas are placed in essentially the same location as would the corresponding ILS antennas. A standard MLS Ground System configuration is shown in figure 7-1.

b. Site Selection. Specific site selection for the MLS equipment at each designated location will be recommended by the contractors and subject to approval by the Government. The site selection process includes, but is not limited to:

(1) A pre-survey conference, requested by the contractors, with airport authorities and regional Government representatives. The purpose of the conference is to ensure that all requirements relating to the specific site are identified and included in the Contractor Site Engineering Report (CSER) as required. Specific site selection for the MLS will be agreed to by the respective FAA region prior to the completion of the CSER. Any site peculiarities such as unusual weather, wind, temperature extremes, jet blast vulnerability, possible flooding, tidal flats, permafrost, etc., will be identified.

FIGURE 7-1. STANDARD MLS GROUND SYSTEM CONFIGURATION



Sites that will require detailed soil investigation boring will be proposed and addressed during the pre-survey conference.

(2) A site survey and evaluation by the contractors to determine equipment and site locations for MLS installation and operation. The contractors will include in the CSER complete details of the recommended facility locations and include a description of alternate locations discussed during the pre-survey conference (along with reason(s) for selecting the recommended locations as opposed to the alternative locations).

(3) Contractor's submittal for Government review and approval of a detailed CSER covering its findings and recommendations. The report will include all essential tasks for site construction and equipment installation. The CSER will be coordinated with the regional representatives prior to submittal to the contracting officer for approval. Once approved, the CSER and specification FAA-E-2721/15, Microwave Landing System Ground Equipment, Turnkey Facility Establishment, become the guiding documents for site engineering/preparation.

#### 71. SITE PREPARATION.

a. Foundation. The quality of the guidance signal of MLS equipment depends, in part, on proper foundation preparation. While settling and other instabilities of foundation will be detected by the field monitor (and can be adjusted out), the resulting shutdowns could create troublesome problems. Consequently, special emphasis is needed to provide foundations having mechanical stability consistent with the inherent accuracy of the system. The planned installation standards handbook for MLS will provide detailed criteria and guidance on this topic.

b. Equipment Interconnections. Site preparation will require the burial of interconnecting cables and installation of a grounding network. Cable trenches are required between the station electronics and the field monitors. Typically, the trenches are 20 centimeters (8 inches) wide and 0.61 meters (2 feet) deep. The interface with electrical power occurs only at the electronics enclosures (or shelters, if used) which should tie directly to commercial power sources. The interface between all facility locations on an airport requires a signal cable with only four to six twisted pairs. Many of the large airports will use existing signal cables with spare circuits to avoid long site-to-site trenching and runway crossing. Although signal communications will normally be accomplished by the use of metallic wire lines, specification FAA-E-2721, Microwave Landing System (MLS), specifies that communication circuit interfaces between MLS equipment hardware shall be provided to accommodate

wire lines, fiber optic lines, and radio links. The type of circuit to be employed at each MLS installation will be specified in the CSER.

c. Topography. The use of the C-band frequency together with radiation control achieved by appropriate antenna design makes MLS relatively insensitive to local terrain. Nevertheless, areas forward of the antenna must be free of tall vegetation and other large/tall obstructions. Further definition on antenna critical zone criteria can be found in Order 6830.3; however, the draft MLS Siting Criteria will be the superseding document once it becomes baselined.

d. Interface With Prime Power. The MLS will be designed for a 60-cycle 120/240 volt three-wire supply.

72. INSTALLATION PLAN. Installation of MLS FAT systems equipment will be performed on a turnkey basis by the contractor(s). The requirements for the contractor(s) , as well as procedures through which the Government will interface with the contractor(s), are specified in the statement of work and FAA-E-2721/15.

73.-79. RESERVED.

## CHAPTER 8. VERIFICATION

80. FACTORY VERIFICATION. The resident Quality and Reliability Officer (QRO) at the contractor(s)' facilities will ensure that factory verification is performed in accordance with contract requirements. Factory verification will include testing of individual computer software configuration items, hardware configuration items, system-level integration testing and testing of the MLS remote monitoring subsystem (RMS). Design qualification testing will be conducted on selected equipments and each equipment will undergo production acceptance testing prior to shipment for field installation.

81. CHECKOUT. Each contractor will perform tune-up, preliminary checks, and a preliminary flight inspection upon completion of the equipment installation to verify satisfactory interface compatibility and performance in accordance with FAA-E-2721 and FAA-E-2721/15. Upon completion of the each contractor's preliminary flight inspection, each contractor will conduct a 120 hour stability run of the installed equipment to demonstrate stable operation. Upon completion of this effort, each contractor will request a formal commissioning flight inspection by the Government. All of the testing conducted by each contractor will be accomplished in accordance with contractor developed/Government approved test plans/procedures.

82. CONTRACTOR INTEGRATION TESTING. Each contractor's integration testing will be conducted as a part of paragraph 81.

83. CONTRACTOR ACCEPTANCE INSPECTION. In lieu of a contractor acceptance inspection (CAI), a Government Acceptance Inspection (GAI) will be performed during which each contractor will demonstrate to the inspection team that the equipment is installed in accordance with the CSER and the equipment instruction books and that all parameters are operating within the maintenance standards and tolerances set forth in the handbooks associated with each equipment. Documentation packages as defined in FAA-E-2721/15 will be provided to the Government at the time of the GAI. Government final acceptance of the complete "Turnkey Facility" will be made following satisfactory completion of the Government commissioning flight inspection (GCFI). If an equipment is to be used in the field reliability demonstration, Government final acceptance will be made after the reliability requirements of the contract have been satisfied.

84. FAA INTEGRATION TESTING. Integration testing will be conducted in accordance with a test plan developed by the

Test Director, ACD-330. This testing will be designed to demonstrate that the interfaces function as required and will include tests to verify the operations of multiple interfaces and integration with other systems in the operational environment.

85. SHAKEDOWN AND CHANGEOVER. Shakedown testing will be conducted in accordance with plans and procedures developed by ASM-600 (and the MLS Shakedown Test Plan Working Group). Testing will be conducted to determine the integrated readiness of an MLS for reliable placement into the NAS. Consideration will be given to compatibility, logistic supportability, and manpower supportability. The test concept will be to focus attention on those MLS attributes which would impact operational readiness, and present a cost and schedule impact to MLS equipment deployment. Additional specifics on the planned shakedown testing can be found in the MLS Master Test Plan.

86. JOINT ACCEPTANCE INSPECTION. A joint acceptance board, in accordance with Order 6030.45A, Facility Reference Data File, inspects and evaluates each MLS installation to determine that the facility has been established in accordance with agency plans, standards, drawings, and specifications; adequately provides for maintenance needs; and is capable of performing its functions on a commissioned basis.

87. PRELIMINARY FLIGHT INSPECTION. Each contractor will perform a preliminary flight inspection (PFI) prior to the GCFI. Each contractor will conduct all tests necessary to ensure that the MLS produces a proper signal throughout the covering sector. The MLS will use an airborne receiver which meets RTCA Inc. standards; azimuth and elevation antennas which demonstrates accuracy in compliance with FAA-STD-022; and a Precision Distance Measuring Equipment (DME/P) interrogator which meets the RTCA Inc. minimum operational performance standards.

88. GOVERNMENT COMMISSIONING FLIGHT INSPECTION. Each contractor will formally request a GCFI when reasonably certain of success, and after a satisfactory preliminary flight inspection has been performed. The contractor's request for a GCFI must be submitted at least 30 days prior to the date required. The Government will allocate up to 10 data gathering flight hours for this inspection and will assume the cost for these hours.

89. RESERVED.



## CHAPTER 9. INTEGRATED LOGISTICS SUPPORT

90. MAINTENANCE CONCEPT. The MLS will employ a two-level maintenance concept, onsite (organizational) and off-site (depot) maintenance as well as a Remote Maintenance Monitoring System (RMMS) capability.

a. Onsite (organizational) level. Onsite maintenance will be accomplished at the deployed site location, and is the responsibility at the regional Airway Facilities division. Repair actions include: (1) repair of MLS systems/subsystems through the removal and replacement of faulty line replaceable units (LRU), cables, and attaching hardware, (2) fault diagnostics using built-in-test (BIT), (3) scheduled preventive maintenance (PM) to include servicing, and equipment certification after restoration.

b. Off-site (depot) level. Off-site maintenance includes: (1) removal and replacement of components/piece parts of LRU's and test, (2) modification and installation of depot modification, (3) alignment and calibration, and (4) troubleshooting and repair. Depot maintenance will be managed by the FAA Logistics Center.

c. RMMS capability. The RMMS will provide the capability to automate and remotely control the periodic tasks of equipment performance monitoring and record site data and support fault isolation, diagnostic testing, and control of remote sites.

91. TRAINING. The MLS contract will have separate options for:

a. MLS FAT Factory Training (maintenance and operator) utilizing each contractor's instructional materials will be the primary training in support of FAT (including the reliability demonstration).

b. The Remote Control and Status Unit (RCSU) User's Guide developed in accordance with FAA-STD-028, Contract Training Programs, for support of operator training.

c. Lecture - Laboratory Classroom Training developed and conducted in accordance with FAA-STD-028 in support of training needs for the planned follow-on production procurement.

d. Computer Based Instruction (CBI) developed in accordance with FAA-STD-028 in support of training needs for the planned follow-on production procurement.

92. SUPPORT TOOLS AND TEST EQUIPMENT. Requirements for support tools and test equipment will be determined during the contractually required National Airspace Integrated Logistics Support (NAILS) program which includes a Logistics Support

Analysis (LSA) in accordance with MIL-STD-1388-1. The only requirement for special test equipment known at this time is for a Portable MLS Receiver (PMR), which will be a deliverable item in the basic MLS contracts.

93. SUPPLY SUPPORT. Detailed supply support requirements will be determined during the contractually required ILS program. Spare parts peculiar requirements will be established in accordance with FAA-G-1375, Spare Parts Peculiar for Electronics, Electrical, and Mechanical Equipment.

94. VENDOR DATA AND TECHNICAL MANUALS. Technical data package including all data and rights will be a deliverable item under the basic contracts. Also, equipment instruction books are being developed by the contractors in accordance with FAA-D-2494, Technical Instruction Book Manuscript: Electronics, Electrical and Mechanical Equipment, Requirements for Preparation of Manuscript and Production of Books.

95. PACKAGING, HANDLING, STORAGE, AND TRANSPORTATION. Support/system equipment and spare parts shipped directly to each designated site location will be prepared for delivery in accordance with (IAW) ASTM-D-3951, Standard Practice for Commercial Packaging. System equipment sent to FAA Logistics Center for storage will be individually preserved/packaged Level A, packed Level B, IAW MIL-E-17555. In addition to marking requirements of MIL-STD-129, each container will be marked as required by Section D of the contract.

96.-99. RESERVED.

APPENDIX 1. LIST OF ACRONYMS

AF	AIRWAY FACILITIES
CAI	CONTRACTOR ACCEPTANCE INSPECTION
CAT	CATEGORY
CBI	COMPUTER BASED INSTRUCTION
CSER	CONTRACTOR SITE ENGINEERING REPORT
DME/P	PRECISION DISTANCE MEASURING EQUIPMENT
DOD	DEPARTMENT OF DEFENSE
DOT	DEPARTMENT OF TRANSPORTATION
DRR	DEPLOYMENT READINESS REVIEW
DT&E	DEVELOPMENT TEST AND EVALUATION
FAA	FEDERAL AVIATION ADMINISTRATION
FAT	FIRST ARTICLE TEST
GAI	GOVERNMENT ACCEPTANCE INSPECTION
GCFI	GOVERNMENT COMMISSIONING FLIGHT INSPECTION
GNAS	GENERAL NATIONAL AIRSPACE SYSTEM
IAW	IN ACCORDANCE WITH
ICAO	INTERNATIONAL CIVIL AVIATION ORGANIZATION
ILS	INSTRUMENT LANDING SYSTEM
IT&E	INTEGRATION TEST AND EVALUATION
JAI	JOINT ACCEPTANCE INSPECTION
LRU	LINE REPLACEABLE UNIT
LSA	LOGISTICS SUPPORT ANALYSIS
MLS	MICROWAVE LANDING SYSTEM

NAILS	NATIONAL AIRSPACE INTEGRATED LOGISTICS SUPPORT
NAS	NATIONAL AIRSPACE SYSTEM
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ORD	OPERATIONAL READINESS DEMONSTRATION
OT&E	OPERATIONAL TEST AND EVALUATION
PFI	PRELIMINARY FLIGHT INSPECTION
PIP	PROJECT IMPLEMENTATION PLAN
PMP	PROGRAM MASTER PLAN
PMR	PORTABLE MLS RECEIVER
QRO	QUALITY AND RELIABILITY OFFICER
RCSU	REMOTE CONTROL AND STATUS UNIT
RMS	REMOTE MONITORING SYSTEM
SLT&E	SYSTEM LEVEL TEST AND EVALUATION
ST&E	SHAKEDOWN TEST AND EVALUATION

9/21/92

6830.4

APPENDIX 2. LIST OF APPLICABLE DOCUMENTS

ORDER 4660.1	REAL PROPERTY HANDBOOK
ORDER 6030.45A	FACILITY REFERENCE DATA FILE
FAA-STD-022D	MICROWAVE LANDING SYSTEM INTEROPERABILITY AND PERFORMANCE REQUIREMENTS
FAA-STD-028	CONTRACT TRAINING PROGRAMS
FAA-STD-036	PREPARATION OF PROJECT IMPLEMENTATION PLANS
FAA-D-2494B	TECHNICAL INSTRUCTION BOOK MANUSCRIPT: ELECTRONICS, ELECTRICAL AND MECHANICAL EQUIPMENT, REQUIREMENTS FOR PREPARATION OF MANUSCRIPT AND PRODUCTION OF BOOKS
FAA-E-2721B	MICROWAVE LANDING SYSTEM (MLS)
FAA-E-2721/15B	MICROWAVE LANDING SYSTEM GROUND SYSTEM TURNKEY FACILITY ESTABLISHMENT
FAA-G-1375C	SPARE PARTS PECULIAR FOR ELECTRONICS, ELECTRICAL, AND MECHANICAL EQUIPMENT
MIL-STD-1388-1A	LOGISTICS SUPPORT ANALYSIS

